Wohlfahrtia
(insect: dipteran)

Overview

Arthropods are coelomate metameric invertebrate animals with a chitinous exoskeleton and jointed limbs. They undergo protostomial embryonic development and grow by cuticular moulting (ecdysis). Three main subphyla are recognized: Chelicerata, Crustacea and Hexapoda. Insects are hexapods with three pairs of uniramous legs, three tagmata (head, thorax, abdomen), ectognathous mouthparts with whole-limb mandibles, and one pair of antennae. Diptera (true flies) have two pairs of wings, but the hindwings are reduced to stabilizing halteres. All species are holometabolans and exhibit complete metamorphosis whereby vermiform larval stages undergo pupation and transform into free-flying adults. Several major parasitic groups are recognized: nematocerans (small slender bodies, long filamentous antennae, narrow wings) and brachycerans (larger bodies, short stout antennae, broad wings); the latter being divided into the Tabanomorpha (larval head capsule sclerotized) and the Muscomorpha (larval head not sclerotized, circular-seamed (cyclorrhaphous) pupae). Muscomorphans include the glossinids (tsetse flies), hippoboscids (louse flies), muscids (house flies), calliphorids (blow flies), sarcophagids (flesh flies) and oestrids (bot flies); all with sponging or biting mouthparts. These flies are either ectoparasitic with adults biting hosts (former three groups) or endoparasitic with vermiform larvae developing in host tissues (latter three groups). Sarcophagids (flesh flies) have large checkered bodies but are not parasitic as adults. Most species are larviparous and normally breed in carrion, but the female will deposit larvae on invertebrate and vertebrate hosts to become facultative parasites. Larvae of *Wohlfahrtia* spp. cause obligate myiases typified by invasive cavernous lesions in livestock, and humans.

Classification:

Domain:	Eukaryota (membrane-bound nucleus)
Supergroup:	Amorphea (unikonts with single flagellum, or nonflagellated amoebae)
Kingdom:	Metazoa (multicellular eukaryotes, heterotrophs, notably animals)
Group:	Protostomia (triploblastic, spiral cleavage)
Subgroup:	Ecdysozoa (cuticle moulted = ecdysis)
Phylum:	Arthropoda (chitinous exoskeleton, segmented body, jointed limbs, haemocoel)
Subphylum:	Hexapoda (three tagmata, three pairs uniramous legs, whole-limb mandibles, Malpighian tubules)
Class:	Insecta (ectognathous mouthparts (bases lie outside head capsule), single pair antennae, many with wings)
Superorder:	Holometabola (Endopterygota) (young do not resemble adults, pupae, with internally developing wings)
Order:	Diptera (true flies, single pair of forewings, hindwings modified into halteres, vermiform larvae)
Suborder:	Brachycera (tabanid/March flies, short stout antennae often with aristae, telmophagy)
Infraorder:	Muscomorpha (Cyclorrhapha) (flies, cyclorrhaphous (circular-seamed) pupae, larval head not sclerotized)
Division:	Schizophora (head with frontal suture (lunule))
Section:	Calyptratae (calypters cover halteres)
Family:	Sarcophagidae (flesh flies, not metallic, breed in excrement/carrion/decomposing organic matter)
Genus:	*Wohlfahrtia* (parasitic on skin/subcutaneous tissues of mammals)
Species:	various species cause myiases

Parasite biodiversity and host range: Most Metazoa are multicellular triploblastic animals with differentiated tissues, many being bilaterally symmetrical with a body cavity. Most invertebrate animals are protostomes as their embryonic development involves spiral determinate cleavage. Those that moult their external cuticles during their life-cycles (process known as ecdysis) are grouped together in the unique clade Ecdysozoa, including the nematodes (roundworms), onychophorans (velvet worms), tardigrades (water bears) and arthropods (myriapods, chelicerates, crustaceans and hexapods). Arthropods have small segmented bodies encased in chitinous exoskeletons with articulated limbs. Most species are free-living in terrestrial and aquatic habitats, although a small range are ectoparasitic on other animals, some feeding on the blood or skin of vertebrates. Five subphyla are recognized: Chelicerata, Crustacea, Hexapoda, Myriapoda and Trilobita. Insects are hexapods with six legs, three distinct body parts, two antennae and mouthparts with whole-limb mandibles. Insects are the most biodiverse group on the planet, with millions of species described in numerous taxa. Notorious ectoparasitic species belong to four orders in two superorders: the Hemipterodea (Exopterygota) containing the orders Hemiptera (bugs) and Phthiraptera (lice); and the Holometabola (Endopterygota) containing the orders Siphonaptera (fleas) and Diptera ('true' flies). Flies are small winged holometabolans that undergo complete (holometabolous) metamorphosis with vermiform larvae undergoing pupation in silk cocoons. Thousands of dipteran species have been described throughout the world, most being free-living saprophages (detritivores) but some being parasitic either as adults biting and feeding on hosts (often haematophagous) or producing larvae that invade host tissues (condition known as myiasis). Two major suborders are recognized: the Nematocera (with small bodies, long filamentous antennae, narrow wings and aquatic larvae and pupae); and the Brachycera (with large bodies, short stout antennae often with aristae and broad wings).

Major parasitic dipteran families	Biodiversity	Parasitic stages	Status	Pathogenesis*	Disease transmission
Suborder: Nematocera (small midges/mosquitoes, thread-horned with long filamentous segmented antennae (= nemato-cera), aquatic life-cycles (larval/pupal stages associated with water), female adults require blood meal before they can lay eggs) (34 families)					
Culicidae (mosquitoes)	3 subfamilies, 70 genera, 3,500 species	adult ♀	obligate	blood-sucking	viral, protozoal, helminth
Psychodidae (moth flies, sand flies)	5 subfamilies, 150 genera, 3,000 species	adult ♀	obligate	blood-feeding	viral, bacterial, protozoal
Simuliidae (black flies)	3 subfamilies, 30 genera, 2,000 species	adult ♀	obligate	blood-feeding	protozoal, helminth
Ceratopogonidae (biting midges)	4 subfamilies, 110 genera, 6,000 species	adult ♀	obligate	blood-feeding	viral, protozoal, helminth
Suborder: Brachycera (large tabanid/March flies, with stout and fewer antennal segments (= brachy-cera), antennae often with aristae, females with slashing-sponging mouthparts to pierce skin and feed on pool of blood (telmophagy)) (120 families)					
Infraorder: Tabanomorpha (larval head capsule incomplete posteriorly (only anterior parts sclerotized))					
Tabanidae (horse flies, deer flies)	3-5 subfamilies, 133 genera, 4,300 species	adult ♀ [+ larvae]	obligate [accidental]	blood-feeding [GI, UG, TR myiasis]	viral, bacterial, protozoal, helminth
Infraorder: Muscomorpha (Cyclorrhapha) (aristate antennae, setose bodies, cyclorrhaphous pupa)					
Section: Calyptratae (calypters cover halteres)					
Superfamily: Muscoidea (synanthropic flies)					
Muscidae (house flies, stable flies)	9-10 subfamilies, 190 genera, 4,200 species	adult ♀, ♂ [+ larvae]	obligate [accidental]	biting, blood-feeding [CU, GI, TR myiasis]	bacterial, helminth
Superfamily: Oestroidea (cause larval myiases) (6 families)					
Calliphoridae (blow flies)	11 subfamilies, 75 genera, 1,100 species	larvae	facultative, obligate	CU, GI, NP, AU, UG TR, myiasis	-
Sarcophagidae (flesh flies)	3 subfamilies, 108 genera, 2,500 species	larvae	facultative, obligate	TR, GI, CU myiasis	-
Oestridae (bot flies, warble flies)	5 subfamilies, 25 genera, 150 species	larvae	obligate	CU, GI, NP, OC myiasis	-
Superfamily: Hippoboscoidea (pupa-bearers)					
Glossinidae (tsetse flies)	1 genus, 3 species-groups, 25 species	adult ♀, ♂	obligate	blood	protozoal
Hippoboscidae (louse flies, keds)	1-3 subfamilies, 21 genera, 212 species	adult ♀, ♂	obligate	blood	viral, protozoal, helminth

*type of myiasis: AU = auricular; CU = cutaneous; GI = gastro-intestinal; NP = naso-pharyngeal; OC = ocular; TR = traumatic; UG = uro-genital.

The suborder Brachycera contains 6 infraorders: Asilomorpha (bee flies, robber flies, spider flies), Muscomorpha (previously suborder Cyclorrhapha) (house flies, blow flies, fruit flies), Stratiomyomorpha (soldier flies), Tabanomorpha (horse, deer and snipe flies), Vermileonomorpha (wormlions) and Xylophagomorpha (awl flies); all of which vary considerably in their morphological and biological characteristics. Members of the infraorder Muscomorpha differ from the others in that they form cyclorrhaphous (circular-seamed) pupae (adults eclose through a circular cap rather than a longitudinal slit), larvae without sclerotized heads, and adults with short pendulous 3-segmented antennae (the third segment often bearing feather-like aristae), palps with a single segment, and feet with 2 pads. Collectively, 15 superfamilies have been classified into 2 Divisions: the Schizophora (containing flies whose heads bear a frontal ptilinial suture and sclerotized lunule); and the Aschiza (hover flies lacking a frontal suture and lunule). Within the Schizophora, 2 sections are recognized: the Calypterae (comprising flies with calypters covering the halteres, large squamae, a strong thoracic suture and well-defined grooves on the antennal pedicels); and the Acalypterae (without covering calypters, small

squamae, a weak thoracic suture and no pedicel grooves). Calyptratae flies are divided into 3 superfamilies: Muscoidea (synanthropic flies with well-developed sponging mouthparts for feeding on decaying organic material or biting mouthparts for blood-feeding, most females being oviparous (egg-layers)); Hippoboscoidea (louse flies and tsetse flies with elongate biting mouthparts for blood-feeding, female flies formerly regarded as pupa-bearers and placed in group Pupipara (now defunct) as they have since been shown to birth mature larvae (considered to be prepupae)); and Oestroidea (blow flies, bot flies and flesh flies whose larvae are endoparasitic and cause myiases). Several superfamilies contain species whose larvae feed on the flesh of vertebrate hosts, mostly when dead (carrion) but sometimes when still living (causing fly-strike). Oestroid and muscoid larvae are well-adapted for living in moist organic substrates ranging from wet faeces to carrion to living flesh.

The superfamily Oestroidea is characterized by large flies that are not dorsoventrally flattened, their wing veins are not crowded, and the discal medial cell of the wings widens gradually. The superfamily contains 7 families: Calliphoridae (blow flies); Oestridae (bot flies); Polleniidae (cluster flies); Rhinophoridae (woodlouse flies); Sarcophagidae (flesh flies); Tachinidae (parasitic flies); and Ulurumyiidae (McAlpine's fly). The family Sarcophagidae contains over 2,500 species whose adults are not metallic in colour (like the blow flies) and whose larvae feed on decomposing organic matter (including excrement and carrion) and sometimes the dermal tissues of living vertebrates. Flesh flies have well-developed mouthparts, dull grey bodies with strong bristles and 3 black stripes on the scutum and spots on the abdomen. Around 108 genera have been described and classified into 3 subfamilies: Miltogramminae (parasitoids of arthropods), Paramacronychiinae (including *Wohlfahrtia*), and Sarcophaginae (including *Sarcophaga*).

Family	Genera	Hosts	Strike	Myiasis*
Sarcophagidae	*Sarcophaga*	mammals	secondary, primary	Facultative or accidental (AU, CU, GI, TR)
	Wohlfahrtia	mammals, birds	primary	Obligate, facultative (CU, TR)

*type of myiasis: AU = auricular; CU = cutaneous; GI = gastro-intestinal; TR = traumatic.

The genus *Wohlfahrtia* (syn. *Afrowohlfahrtia, Bracia, Disjunctio, Eubracia, Hemibracia, Pandellea, Paraphyto, Wohfartia*) contains 27 species which have been described as parasitoids of insects (orthoptera), necrophages of carrion or as facultative (occasionally obligate) parasites of warm-blooded vertebrates, predominantly artiodactyls (sheep, goats, cattle, camels), perissodactyls (horses), some carnivores (dogs) and occasionally humans and even poultry. They are large flies with bristly bodies, spotted abdomens and long black legs. Vertebrates become infected when gravid female flies deposit larvae near wounds or body orifices resulting in tissue invasion and furuncular myiasis.

***Wohlfahrtia* species**	Hosts	Clinical signs	Distribution
W. africana	trapped*		Africa
W. aschersoni	trapped		Africa
W. atra (syn. *Sinotibetomyia curvifemura*)	trapped		Asia
W. balassogloi	carrion	necrophagous	Asia
W. bella	trapped	facultative myiasis	Africa, Eurasia
W. brevicornis	trapped		China
W. brunnipalpis	carrion	necrophagous	Africa
W. cheni	trapped		Asia
W. erythrocera	Orthoptera (grasshoppers), carrion	parasitoid, necrophagous	Africa, Central Asia
W. euvittata	Orthoptera (locusts)	parasitoid	Africa
W. fedtschenkoi	carrion	necrophagous	Eurasia
W. grunini	trapped		Eurasia
W. ilanramoni	trapped		Eurasia
W. indigens (syn. *W. aethiopica, triquetra*)	trapped, carrion	necrophagous, facultative myiasis	Africa, Eurasia
W. intermedia	carrion	necrophagous	Eurasia
W. magnifica (syn. *W. hirtiparafacialis*) (spotted flesh fly, Wohlfahrt's wound myiasis fly)	Artiodactyla: bovid (cattle, sheep, goat) camelid (camel), suid (pig); Perissodactyla: equid (horse); Carnivora: canid (dog); Primates: hominid (human); Galliformes (poultry): other wild and domestic animals	obligate myiases (cavernous lesions, liquefaction, necrosis, haemorrhage)	Eurasia, Africa

W. monegrosensis	trapped		Europe
W. nuba (syn. *W. longicorpuris, volucris*) (flesh fly)	Artiodactyla: camelid (camel); Primates: hominid (human); other wild and domestic animals, carrion	necrophagous, secondary facultative myiasis (deepening lesions) [forensic applications]	Africa, Eurasia
W. pachytyli	Orthoptera (locusts); Artiodactyla: bovid (cattle)	parasitoid, facultative myiasis	Africa
W. pavlovskyi	carrion	necrophagous	Eurasia
W. seguyi	trapped		Africa
W. smarti	trapped		Africa
W. spinisternum	trapped		China
W. stackelbergi	carrion	necrophagous	Eurasia
W. trina	trapped, carrion	facultative myiasis	Africa, Eurasia
W. vigil (syn. *W. meigenii, opaca*) (grey flesh fly, fox maggot)	Carnivora: canid (dog, fox, silver fox), felid (cat), mustelid (mink, ferret); Lagomorpha: leporid (rabbit, cottontail); Rodentia: cricetid (meadow vole); Mammalia (other wild and domestic animals); Primates: hominid (human); Anseriformes: anatid (ducklings); Anura (unspecified frogs, toads)	necrophagous, facultative myiasis (furuncular)	Holarctic
W. villeneuvi (syn. *W. musiva*)	carrion	necrophagous	Eurasia, Africa

*Adult flies caught in traps or larvae deposited in flesh baits.

Parasite morphology: *Wohlfahrtia* spp. form 4 types of morphological stages during their development: namely, eggs (*in utero*), larvae (3 instars), pupae (in puparia), and adult flies (male and female). The eggs are retained in bilobed expansions of the uterus in female flies where they embryonate and hatch to release larvae. Female flies are viviparous and birth live larvae. The larvae (known as maggots) have cylindrical cream-yellow bodies that taper anteriorly to a narrow head and are truncated posteriorly. They develop through 3 larval instars (L1-3) and grow from 4-5 mm up to 20 mm in length. They do not have a sclerotized head capsule but have an internal cephalopharyngeal skeleton bearing 2 curved mandibles. Their bodies have 12 conspicuous segments, most with distinct segmental bands of small spines (muscoid larvae lack body spines). Larvae breathe using 2 pairs of respiratory spiracles, a small anterior pair located laterally on segment 2, and a larger posterior pair located caudally in deep pits on segment 12. The anterior spiracles appear as small branched fans, while the caudal spiracles appear as plates with an incomplete perimeter (peritreme) surrounding 3 oval slits slanted away from the midline (muscid larvae have slits slanted towards the midline, while oestrid larvae have porous spiracular plates). Mature L3 form barrel-shaped puparia 8-10 mm long which are initially creamy-yellow in colour but slowly darken to red-brown as they age. The enclosed pupae undergo metamorphosis to form a winged adult fly which emerges through a circular pupal cap (like all Cyclorrhapha). Adult flies are relatively large measuring 6-10 mm in length and they resemble house flies but do not have metallic-coloured bodies. Instead, they have dulled dark bristly bodies with prominent thoracic stripes and abdominal spots. Adults have 3 body tagma: an oval head, slender thorax, and stout abdomen. The head has both a ptilinal suture and facial lunule (like other Oestroidea and Muscoidea, but unlike other calyptrates), 2 well-developed red-brown compound eyes located laterally (closer together in males than females), 2-5 postsutural dorsocentral bristles, but bare cheeks (setate in *Sarcophaga*). Adults have 2 anterior flagella, each consisting of 3 dissimilar segments: a short basal scape; a club-like pedicel with a complete dorsal seam; and an anterior flagellum comprising a single large dorsal bristle (arista) without any setae. The mouthparts are located on a ventral proboscis flanked by short club-like palps. Flies have sponging mouthparts without piercing elements (adults are not blood-feeders). The proboscis comprises a short rostrum, a longer cylindrical haustellum (with a sheath-like labium framing an anterior labrum and a slender hypopharynx) and a flattened terminal sponging labellum. Ingested food is directed through a tubular oesophagus to a globular proventriculus (with saccular diverticula) and then passed into the midgut (for digestion), hindgut (with excretory Malpighian tubules), rectum and terminal anus. The thorax is covered by a shield-like scutum but lacks a posterior lobe-like scutellum. There are 2 sets of bristles on each side of the thorax and under the wings (lacking in muscid flies), 4 notopleural bristles, and a vertical row of bristles on the thoracic meron (present in all oestroid flies, but lacking on muscoid flies). The mesothorax gives rise to 2 clear membranous wings whose membranes are supported by 6 primary veins [costa (C), subcosta (Sc), radius (R), media (M), cubitus (Cu), and anal (A)], with costal spine being as long as the r-m crossvein, and the M vein curving sharply up towards the outer leading edge. The hindwings have been highly reduced to a pair of small club-like halteres used to stabilize flight (like all Diptera), and the halteres are covered by posterior wing lobes (like all calyptrates). Flesh flies also have bulbous swellings (greater ampullae) beneath their wing bases. The ventral thorax is the point of attachment for 3 pairs of long black legs, each composed of 5 segments (coxa, trochanter, femur, tibia, and tarsus) and all terminating in 2 claws and large pad-like pulvilli. The segmented abdomen has distinctive patterns of black median and lateral spots (median ones partially coalescing) and the terminal segments are modified by genital structures (male aedeagus and claspers, female larvipositor). Male flies have 2 testes linked by vas deferens to a seminal vesicle (with lateral accessory glands) that leads to a tubular ejaculatory duct and retractable

copulatory aedeagus. Female flies have 2 ovaries joined by oviducts to a globular uterus (with associated spermatheca and accessory glands). Fertilized eggs are retained in expanded bilobed uterine pouches and larvae are birthed through a terminal telescoping larvipositor.

Site of infection: Adult *Wohlfahrtia* flesh flies are not parasitic on hosts, but females produce larvae which can invade host tissues. The larvae of some *Wohlfahrtia* spp. are internal parasitoids of insects (particularly grasshoppers), while others are necrophages of carrion and sometimes facultative (occasionally obligate) parasites of warm-blooded vertebrates. In particular, larvae of the Old World species *W. magnifica* and the New World species *W. opaca* and *W. vigil* may initiate cutaneous myiasis as primary (obligate) invaders. Infestations have been recorded predominantly in artiodactyls (sheep, goats, cattle, camels), perissodactyls (horses), some carnivores (dogs) and occasionally humans and even poultry. Larvae have been found mostly in association with wounds or host orifices, including the mouth, nose, eye, ear, perineum and genitalia, but have occasionally been detected elsewhere on the body.

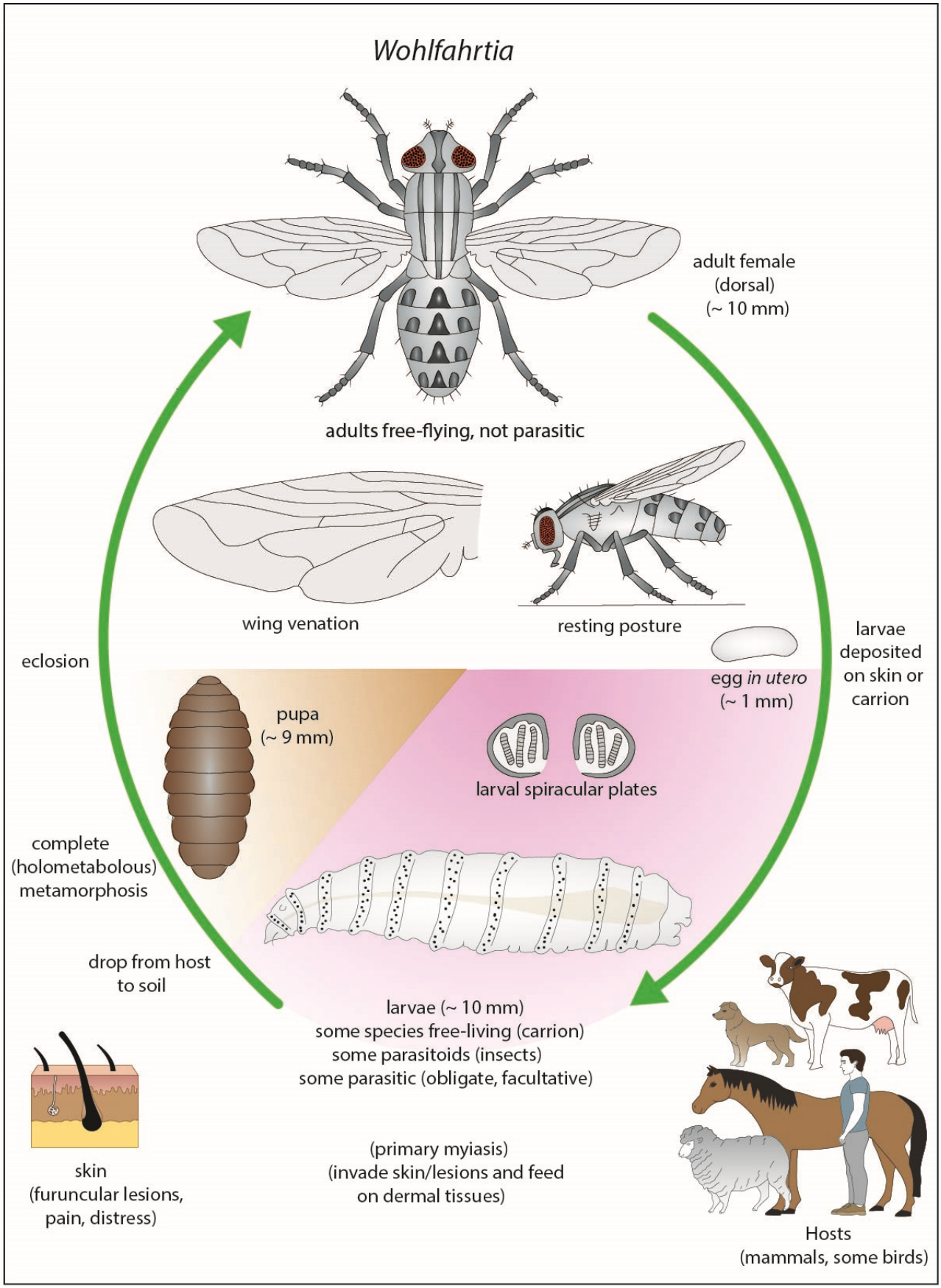
Pathogenesis: Female flies are strongly attracted to flesh but they are not blood or tissue feeders. Instead, they deposit (larviposit) larvae on carrion or on fresh wounds and scratches and moist body openings on live animals. The larvae invade cutaneous tissues using their rasping-cutting mouthparts, on occasion even penetrating thin unbroken skin. The larvae burrow into subcutaneous tissues to feed and grow through 2 more larval instars. They usually cause furuncular (boil-like) lesions, sometimes abscesses, containing one or a few larvae which breathe through a central punctum (pore or puncture point) in the pustule. Occasionally, they may cause more expansive lesions packed with larvae (similar to those caused by screwworm larvae). After approximately one week, mature larvae leave the wounds and drop to the ground to pupate. The pain and stress associated with cutaneous lesions may be severe, with animals becoming distressed and often attempting to relieve the irritation by biting, scratching or rubbing lesions. This may result in self-trauma exacerbating wounds making them haemorrhagic, necrotic and open to secondary bacterial infections. Animals may become anorexic, weakened, and lose condition resulting in production losses in livestock, and sometimes succumb to heavy infestations. Humans rarely become infested, although even a few larvae in ectopic locations (particularly nasal passages) can have serious clinical consequences.

Developmental cycle and mode of transmission: Like all Diptera, flesh flies exhibit holometabolous development where grub-like larvae undergo complete metamorphosis in pupae to form winged adult insects. However, unlike most other flies, *Wohlfahrtia* spp. are not oviparous and do not lay eggs. Instead, they are viviparous and give birth to first-stage larvae (L1) which develop in eggs retained in uterine pouches. Gravid female flies deposit several larvae head-first through their larvipositor onto carrion, or near host wounds or orifices on live animals. The larvae feed on flesh for 4-8 days and grow through another 2 larval instars (L2-3). When replete, mature L3 leave the wounds and drop to the ground. They burrow into the soil and form puparia by contraction and hardening of their teguments. Pupae develop inside the cases and transform over 4-12 days into adults (although pupation can be delayed in cooler condition, with some species in temperate regions over-wintering as pupae). Adult flies emerge from pupae through circular caps and after a brief period of rest to harden their cuticles, they fly in search of food and mate 3-4 days after eclosion. Adult flies feed on plant liquids (nectar and sap) but are attracted to flesh for larviposition. Female flies deposit 6-16 larvae at a time and may produce 120-170 larvae over their 35-40 day lifespans. The entire life-cycle may be completed in 4-6 weeks, but generally takes longer in cooler conditions. In most endemic regions, infestations occur seasonally with the incidence being highest over summer. Epidemiological studies in several countries also indicate considerable annual variation in incidence with some years having massive outbreaks for undetermined reasons.

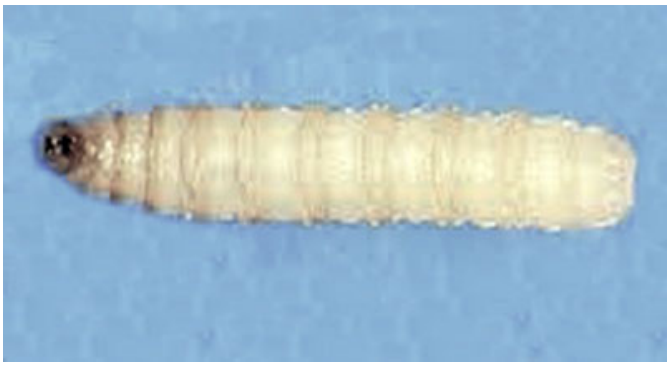
Differential diagnosis: The differential diagnosis of cutaneous myiases on clinical grounds and history is difficult due to the nonspecificity of signs and symptoms and the large number of possible aetiological agents (especially other fly species which may cause myiasis). Infestations are conventionally diagnosed by the detection and collection of larvae from wounds, and their identification on the basis of their morphological characteristics (notably, oral hooks, segmental bands and spiracles, all of which are more prominent on mature larvae). On occasion, larvae may also be cultivated in the laboratory on meat or synthetic media until they pupate and release winged adults for identification. A range of molecular biological studies have been used to identify and characterize species by polymerase chain reaction (PCR) amplification of nuclear (ribosomal DNA) and mitochondrial (cytochrome oxidase I and II) gene sequences.

Treatment and control: Wounds infested with maggots are best treated promptly using antiseptic techniques to cleanse and debride wounds. Larvae may be extracted by using tweezers or forceps, by flushing with lidnocaine and epinephrine, or by surgical excision and extraction under local anaesthesia. Larvae may also be made more amenable to extraction by smothering their spiracles with occlusive dressings of oils or fats (such as petroleum jelly, mineral or vegetable oil, liquid paraffin, beeswax, butter, pork fat, and sometimes nail polish, adhesive tape, or chewing gum). Supportive therapy with analgesics, anti-inflammatories, antibiotics, and rehydration may be given to alleviate symptoms and counter secondary infections. Care should be taken not to damage larvae during extraction to prevent inflammatory responses to larval fragments. A number of ready-to-use dressings containing insecticides are also available in most countries for treating wounds either therapeutically or prophylactically after shearing, branding, tagging, dehorning, tailing or castration. Insecticides may be applied as powders, sprays, salves or compression dressings containing

organochlorines (lindane), organophosphates (diazinon, chlorpyrifos, trichlorfon), carbamates (carbaryl, propoxur) or synthetic pyrethroids (permethrin, cypermethrin, deltamethrin). Insecticides with good residual activity may also be used to protect livestock and companion animals against flesh flystrike, including pour-on insect growth regulators (dicyclanil, cyromazine) and some systemic macrocyclic lactones (doramectin, although ivermectin and moxidectin are often ineffective). Efforts to control other blood-sucking parasites (ticks, mites, fleas, lice and other flies) often reduce the incidence of flesh fly myiasis, as *Wohlfahrtia* flies are often attracted to wounds caused by these parasites. The prevention of infestations is based around breaking transmission cycles by killing adult flies (with aerosol insecticides), restricting their access to hosts (through better housing with window and door screens) and eliminating potential breeding sites (through improved sanitation, removal of faeces, disposal of carcases). Individuals working in endemic regions during fly season may benefit from applying insecticides or repellents to skin or clothing, and by maintaining personal hygiene. Several studies have been conducted on the use of *W. nuba* for ‘maggot therapy’ for treating ragged infected wounds in humans, as this species feeds only on necrotic flesh (similar to *Lucilia sericata*).


Wohlfahrtia
adult female
(dorsal)
(~ 10 mm)
adults free-flying, not parasitic
wing venation
resting posture
larvae
deposited
on skin or
carrion
egg in utero
(~ 1 mm)
eclosion
pupa
(~ 9 mm)
larval spiracular plates
complete
(holometabolous)
metamorphosis
drop from host
to soil
larvae (~ 10 mm)
some species free-living (carrion)
some parasitoids (insects)
some parasitic (obligate, facultative)
(primary myiasis)
(invade skin/lesions and feed
on dermal tissues)
skin
(furuncular lesions,
pain, distress)
Hosts
(mammals, some birds)

Wohlfahrtia adult



Wohlfahrtia larva

Wohlfahrtia pupa